OLTARIS User Guide

[Note: The user guide is in the process of being updated for the most recent update to the website. So far, about half of the document has been updated. The rest of the information is still relevant, but the images may not match what you see on the site.]

Introduction

On-Line Tool for the Assessment of Radiation in Space (OLTARIS) is a internet-based tool that assesses the effects of space radiation to humans and electronics in items such as spacecraft, habitats, rovers, and spacesuits. This document explains how to input data, perform assessments, and examine results using the web-based user interface.

The OLTARIS architecture is divided into two main parts, the website, in which users interact through a browser, and the execution environment, where the computations are performed. The website is built primarily with standard open source components. The core is Ruby on Rails with a MySQL database running on an Apache web server. The only licensed, server-side component is an Adobe Flash plugin which allows the users to plot and examine results using a standard, free plug-in.

The execution environment is primarily FORTRAN executables tied together with some Perl and Ruby scripts running on a computational cluster. Data is passed between the web server and the cluster using XML files. Jobs are managed with the open-source Sun Grid Engine (SGE).

OLTARIS requires a browser (Firefox, Chrome, Internet Explorer, and Safari have been tested) with JavaScript and Adobe Flash support. The login system requires that the browser's settings are set to allow cookies. It is sufficient to only enable "session" cookies and the cookies will only exist in the browser's memory until the user closes the browser or logs off OLTARIS.

Registration

User Accounts

Users need to register on OLTARIS and have the account activated before they can enter the website. This is done to regulate demand and maintain limited computer resources by permitting only those with a real need and knowledge to access the site. Once the user account has been activated by the site administrator, the user can login and start using the tools.

Home Page

The home page is at https://oltaris.nasa.gov/. The home page is used for logging on to OLTARIS. The home page also contains links for registering for a user account, changing the user's password, and viewing documentation. Beneath the login form and links is posted general

information about system requirements, general use, current capabilities and a list of known issues.

Site Administrator

The NASA Official link that is located in the footer of each OLTARIS web page is an email link to the site administrator.

Registering for an account

The register link on the OLTARIS home page brings up a form for requesting an OLTARIS user-account. The form provides the information that the site administrator needs to determine that a person qualifies for an account. The form is also the mechanism through which the user specifies a user name and password for the account. The user receives an auto-reply to confirm receipt of the application. The site administrator reviews and verifies the registration and gets the necessary security approvals. If approved, the user receives an email from the site administrator announcing that the account is activated. If declined, the user receives an email requesting further information.

Logging on to OLTARIS

The user logs on to OLTARIS from the home page by entering a user name and a password.

Changing a Password

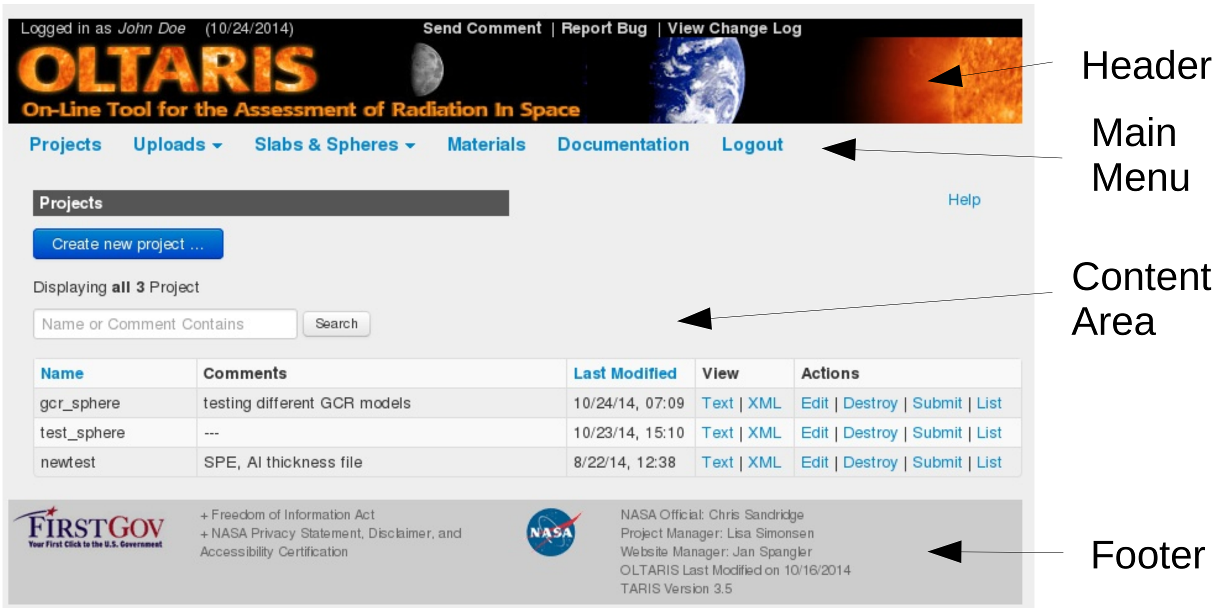
The *Forgot your password?* link is on the home page. The user is prompted to enter the email address used to set up the account and then a link will be sent to that email address that can be accessed to change the password.

Forgotten User Name

The user must contact the site administrator directly to retrieve a forgotten user name.

General Usage

Screen Layout



Header Area

At the top of the page header is the name of the user that is logged in and the current date. Below that are 3 links:

Send Comment	Email link for contacting the site administrator.
Report Bug	Email link for reporting issues that the user feels is a bug in the product.
View Change Log	Brings up a log or record of changes made to the website, including records such as bug fixes, new features, etc.

Main Menu

The main menu is arranged as a series of tabs and pull-down menus. Selections from the main menu send the user to different modules (i.e., main sections) of the OLTARIS website. When the user logs in, they start on the Project page.

Content Area

This area provides screens in which users can create and interact with their data. Every screen has one or more help links, indicated with a 'Help' along the right margin. Selection of a help link brings up a window that contains pertinent usage information. Some areas also have a 'Reference' link that brings up more detailed information about the models and gives the users

lists of publications pertaining to the specific model. Error messages and warnings are usually displayed at the top of the content area.

Footer

The footer contains email links to the NASA Official (see section on site administrator), the Project Manager, and the Website Manager. The footer also displays the date that the OLTARIS website was last modified and the release number of the TARIS FORTRAN code running on the computational cluster. This version number is also saved with the results as the jobs are run.

Data

Data Types

There are 5 main categories of user data:

Data Type	Description
Projects	Projects are the top-level containers for radiation analyses. Each project includes a definition of the radiation environment, a geometry selection, and a selection of desired responses.
Jobs	A job is an instantiation of a project that is packaged for processing. Jobs are created whenever a project is submitted for processing. Multiple jobs can be associated with the same project.
Uploads	An upload can be a space vehicle thickness distributions or a user-generated spacecraft trajectory.
Slabs & Spheres	User-defined slab and sphere geometries.
Materials	User-defined materials.

Data is presented to the user in lists. For example, as shown in Figure 2, selection of Projects from the main menu would cause all of the user's projects to be displayed as entries in a list:

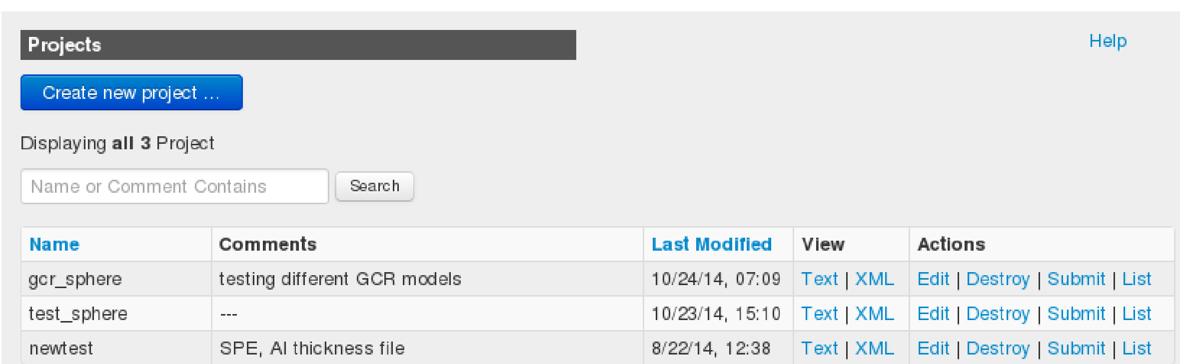


Figure 2 Projects List

The user can list any category of data through selection of the corresponding item from the main menu. The only exception is the Jobs List which is linked to from within the Projects Module.

Data Lists

Data lists all have a similar format:

Column	Description
Name and Comments	The name and comments fields allow the user to categorize projects as they wish. Hovering the mouse over the text and left-clicking lets the user edit the name or comments inline.
Last Modified	The date and time at which any attribute of the data object was last modified.
View	Selection of the Text link displays a user friendly summary of the project. Selection the XML link displays the XML description of the project. The View column only appears in the Projects list.
Actions	This column contains links for updating the state of the data object such as edit, delete, etc.

Lists are ordered by the last modified date but default but can also be ordered by name by selecting the column heading. Lists with many entries are paginated (i.e., the list is split over several pages) such that there are no more than 15 entries per page. Next and Previous links at the top of a paginated list cycle the user through the different pages. The search box which appears above the data list is used to filter which objects are displayed in the list. Only those objects that contain the search term in either the name or comments field will appear in the list.

User-defined Data vs. System-owned Data

The thickness distributions and materials lists contain both user-defined data and system owned data. System-owned data are designated with an asterisk '*' and are listed after all the user-owned data. For example, as shown in Figure 3, the user's thickness distributions are listed first and the system-owned thickness distributions are next and marked with an asterisk. User-defined data are data objects that are created by the user and can be edited, viewed, and deleted. System-owned data can only be viewed or referenced in other data.

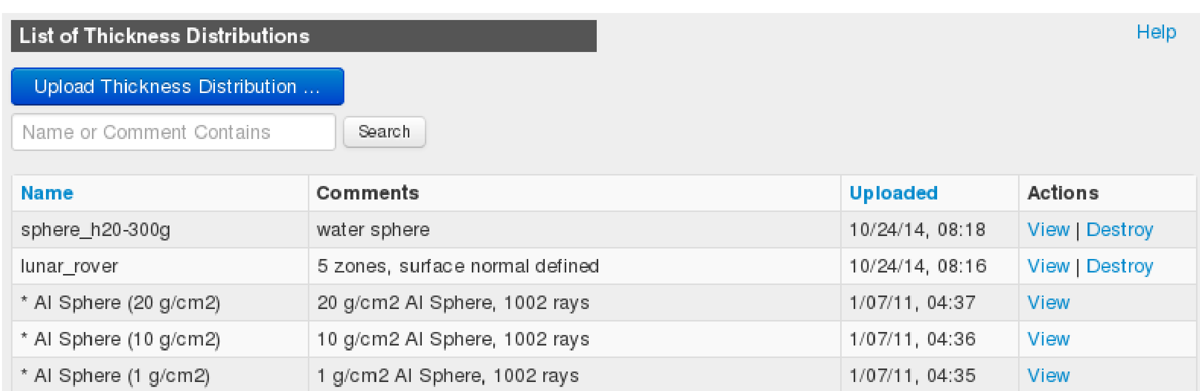


Figure 3 Thickness Distribution List contains both user-defined and system-owned data objects.

Creating New Data Objects

New data objects are created by clicking on the button that appears above the data list. For example, as shown in Figure 2, selection of the 'Create New Project …' button redirects the user to a form for defining the different aspects of a radiation analysis. Submission of the form returns the user to the list. The newly created object appears as the first item in the data list.

Editing Data Objects

Selection of the edit link redirects the user to a form that can be used to edit the data object.

Delete Data Objects

Selection of the destroy link deletes a data object. For most data objects, the user is asked to confirm the delete.

OLTARIS Modules

This section describes the major modules of the OLTARIS website. Modules are entered by selecting items from the main menu.

Projects

Each project is the complete encapsulation of a radiation analysis; it includes the definition of the radiation environment, the selection of a thickness distribution or slab, and a selection of desired responses. The Projects Module allows the user to create new projects, edit existing projects, submit new jobs to the compute cluster, and access the results of previous jobs. A job is an instantiation of a project that is packaged for processing. When a new project is created, the user works from the top down to define the different aspects of the problem. Once the project is saved, the user is returned to the Projects List or can submit a job to the compute cluster.

Once a job is submitted, the user can check on the status of the job from the Jobs List for the project. Also, when a job is complete, an email will be sent to the user from the grid scheduler. Once the job is complete, the user can view the results by selecting the Show Results link for the completed job in the Jobs List.

Project List

The user interface for the Projects List is as described in the General Usage section of this document. There are 4 links in the Actions column:

Link	**Description**
Edit	Redirects the user to a form for editing the project.
Destroy	Deletes the project.

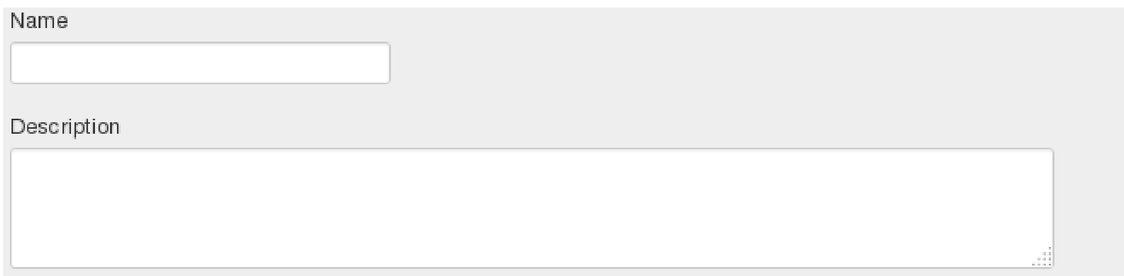
Submit	Once a project is fully defined, it is ready to be submitted to the computational grid for processing. The Submit link redirects the user to a form that lets the user enter a name for identifying the job within OLTARIS and comments. Submission of the form sends the job to the grid scheduler and then redirects the user to the Projects List. A message box appears at the top of the Content Area. The message informs the user whether OLTARIS was successful in submitting the job to the grid scheduler.
List	Redirects the user to the Jobs List. This list will contain all the jobs that have been submitted for that particular project. If no jobs have been submitted, the List Jobs link is not displayed.

The button above the Projects List redirects the user to the form for creating a new project. The forms that are used for creating and editing projects have identical formats.

Form for Creating and Editing Projects

Name and Comments

At the top of the form are input areas for entering a project name and comments:



The Project Name must have between 4 and 30 characters, and it cannot contain white-space or any special characters. Entry of comments is optional.

Environment Selection

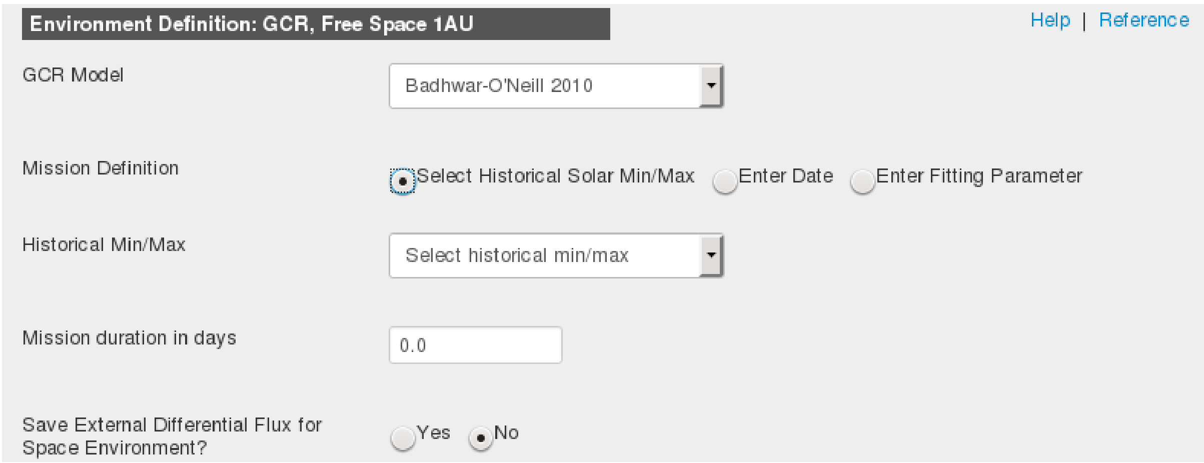
This section of the Project Form is for defining the project's external environment. If no environment has been selected, the user will be presented the following display:

Selecting the pull-down menu, there will be a list of options that are described in further detail below. These environments are currently available on OLTARIS:

Environment	**Description**
GCR, Free Space 1 AU	Free space galactic cosmic ray environment at 1 AU.
GCR, Lunar Surface	Free space galactic cosmic ray environment at 1 AU for each ray emanating from free space to the target point. Surface-pointing rays are exposed the the neutron albedo computed by applying the free-space GCR to the lunar regolith and computing the back neutrons. Lunar-surface environments can only be run with thickness distributions.
GCR, Mars Surface	The free-space galactic cosmic ray environment at 1 AU is applied to a modified vehicle thickness file that is process in a ray-by-ray transport analysis. Each ray pointing away from the surface is augmented with the appropriate amount of Mars atmosphere based on one of two models. The surface pointing rays are augmented with 300 g/cm2 of Mars regolith, which will automatically take into account the neutron albedo in the bi-directional transport.
SPE, Free Space 1 AU	Free space solar particle event environment at 1 AU.
SPE, Lunar Surface	Free space solar particle event environment at 1 AU for each ray emanating from free space to the target point. For each ray emanating from the lunar surface to the target point, the external environment is assumed to be zero. The lunar neutron albedo component is not included at this time. The orientation of the vehicle or habitat with respect to the lunar surface is defined by specifying a material type four thickness in the XML thickness file for each ray emanating from the lunar surface to the target point. Note that this environment requires the selection of a thickness distribution. Currently lunar environment cannot be processed for slabs.
SPE, Mars Surface	The free-space solar particle event environment at 1 AU is applied to a modified vehicle thickness file that is processed in a ray-by-ray transport analysis. Each ray pointing away from the surface is augmented with the appropriate amount of Mars atmosphere based on one of two models. The surface pointing rays are augmented with 300 g/cm2 of Mars regolith, which will automatically take into account the neutron albedo in the bi-directional transport.
Earth Orbit / Trajectories	GCR environment with altitude and inclination dependent cutoff, trapped protons, and albedo neutrons.
Europa Mission	Design reference environments for the earlier-planed joint NASA/ESA mission to Europa.

Free-Space GCR Environments

The sub-form for entering a GCR-type environment looks like this:



The user first selects which GCR model to use from the pull-down menu. The current default is the Badhwar-O'Neill 2010 model, but the user can also select either the Badhwar-O'Neill 2006 model or the Matthia 2013 model.

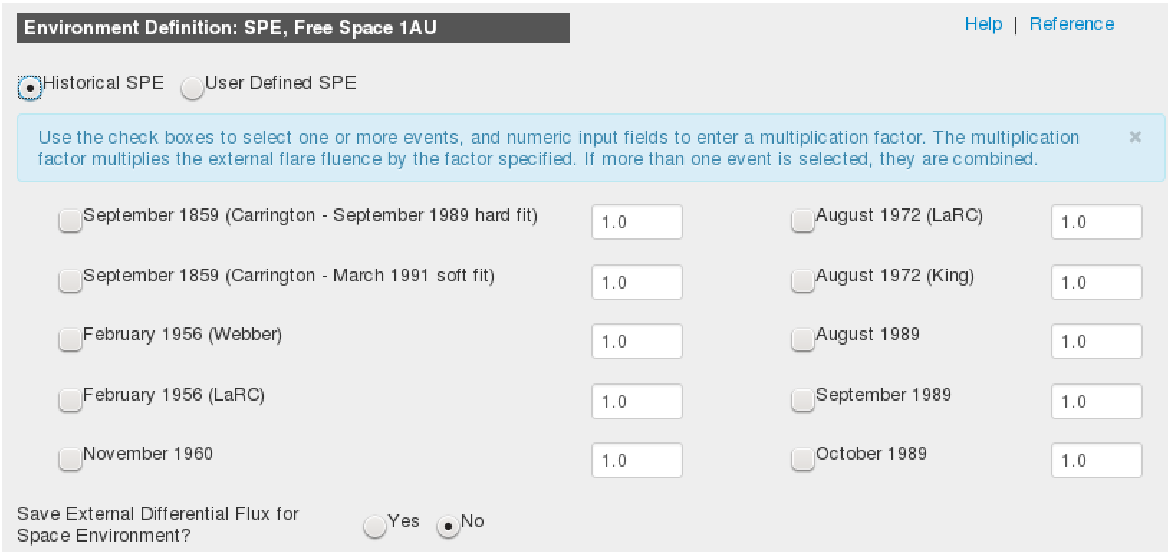
The mission definition has 3 options:

- If the “Select Historical Solar Min/Max” radio button is selected, the user chooses a historical solar minimum or solar maximum and enters the mission duration in days to define the mission length.
- If the “Enter Date” radio button is selected, the user enters a start and end date for the mission. The "Duration in Days" field will either display the length of the mission if start and end dates are given, or it can be used to specify the length of a mission if only a start date is given.
- If the “Enter Fitting Parameter” radio button is selected, the user enters the appropriate fitting parameter depending on which GCR model is chosen and a mission duration in days.

In all 3 cases, mission duration can be entered in fractions of a day. For example, 2.5 would specify 2 days and 12 hours.

At the bottom of the sub-form, the user indicates whether or not to save the environment for plotting and analysis.

Free-Space SPE Environments



There are two main options for defining an SPE environment:

- If the “Historical SPE” radio button is selected, the user chooses any combination of events to include in the total SPE environment. Multiplication factors can also be entered to reduce or increase the spectrum of a particular event. If more than one SPE is selected, the spectra are summed.

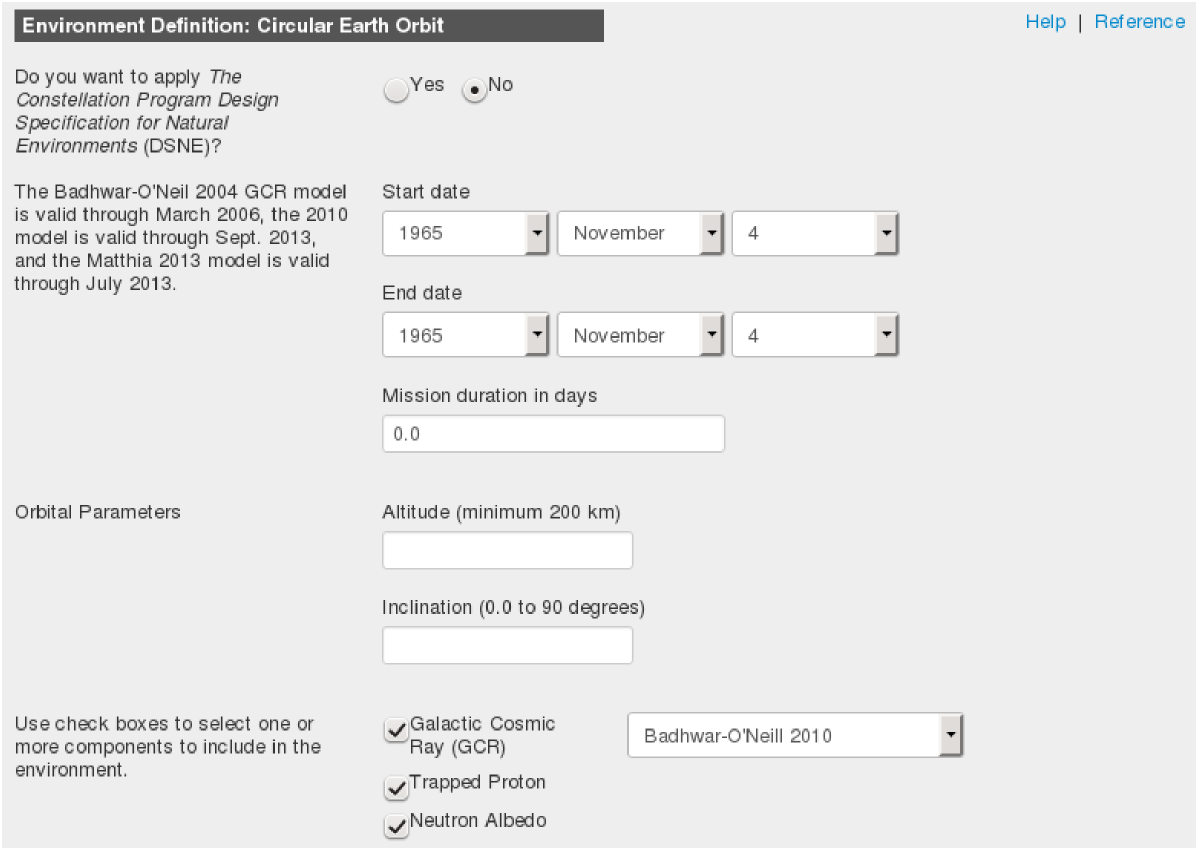
- If the “User Defined SPE” radio button is selected, the user is provided a second set of radio buttons for selecting one of several curve fits for defining the SPE: Weibull, Exponential in Energy, Exponential in Rigidity or Band Function. Once a curve fit is selected, the equation will be displayed and the user is provided input fields for entering appropriate parameters as indicated in the equation.

Earth Orbit Environments

There are two menu options for creating Earth-orbit environments, Circular Earth Orbit or User Trajectory. The first computes day averaged circular orbits based on altitude, inclination and date. The second uses a user-uploaded trajectory to compute an averaged environment over the entire trajectory or at every point in the trajectory when the job is submitted as a 'point-by-point' analysis.

Circular Earth Orbit

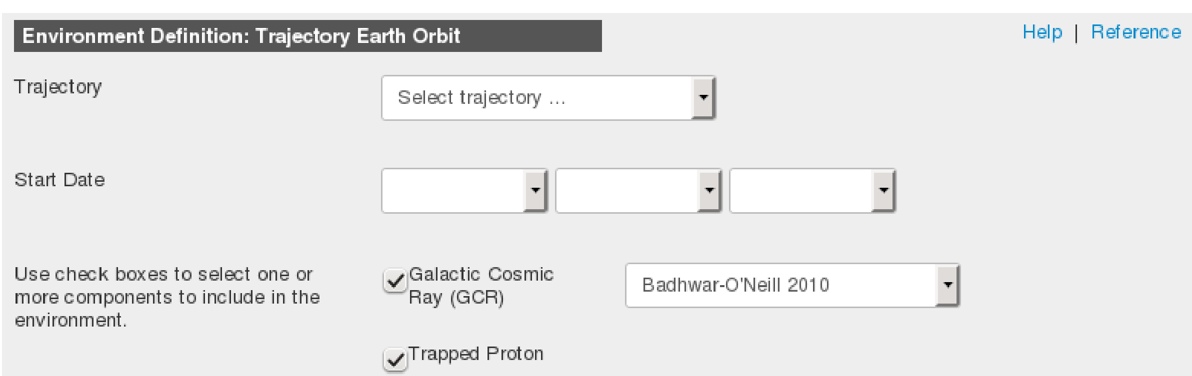
The form for the circular Earth orbit environment is shown below:



The user first chooses whether or not to apply the Design Specification for Natural Enthronements (DSNE) from the Constellation Program. If 'yes' is selected, all of the environment options are automatically filled in and the Mission Duration is the only field the user can modify. Otherwise, the user selects the start and end dates (or start date and mission duration), the altitude, inclination, and which components to include in the environment. If GCR is selected, the user can also choose which GCR model to use.

User Trajectory

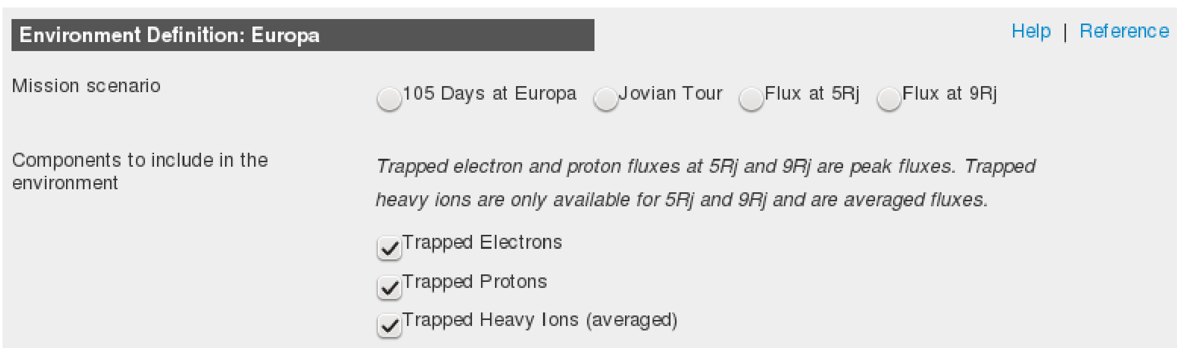
The form this environment is shown below:



The user will first have to have uploaded one or more trajectories under the tab titled 'Uploads/Trajectories.' Once that is done, the user can select which trajectory to use in the pull-down menu. If there is a start date included in the trajectory, that date will be filled in automatically in the next field, which can then be changed if desired. This allows the same trajectory to be used for multiple mission analyses. Finally the user chooses which components to include and the GCR model desired. The neutron albedo is not available for user trajectories.

Europa Reference Environments

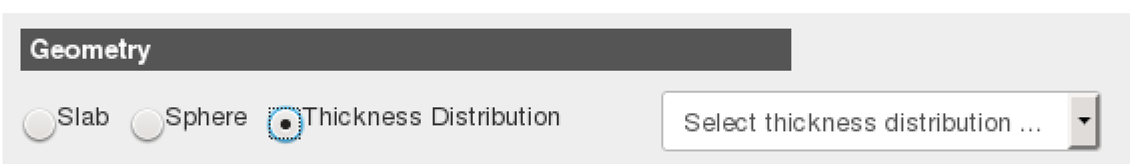
The available reference environments for the joint US/ESA missions to the Europa were added to OLTARIS when the mission was in it's planning phase. That original mission was canceled, but these environments are still available for use. However, the link to the JPL reference site no longer exists so descriptions of the mission scenarios are not available. The form is shown below:



The user can select one of four mission scenarios and then select which components to include. The trapped heavy ions are only available for the 'Flux at 5Rj (5 times the radius of Jupiter)' and 'Flux at 9Rj' mission scenarios. The only response available for these environments is dose in silicon.

Geometry Selection

The “Geometry” section of the Project Form is used to select a slab, a sphere, or a thickness distribution for the project geometry:



Selection of a radio button will populate a drop-down menu with the available choices. The type of geometry that is selected determines which type of transport will be used during the radiation analysis. Slab geometries are near limitless combinations of materials and layers in any order to which the external environment, or boundary condition, is transported from face to face using a

straight ahead transport with bi-directional or backscattered neutrons. The advantage of slabs is that they are fast calculations and any material defined by the user can be used. Responses are returned at the interface between each layer.

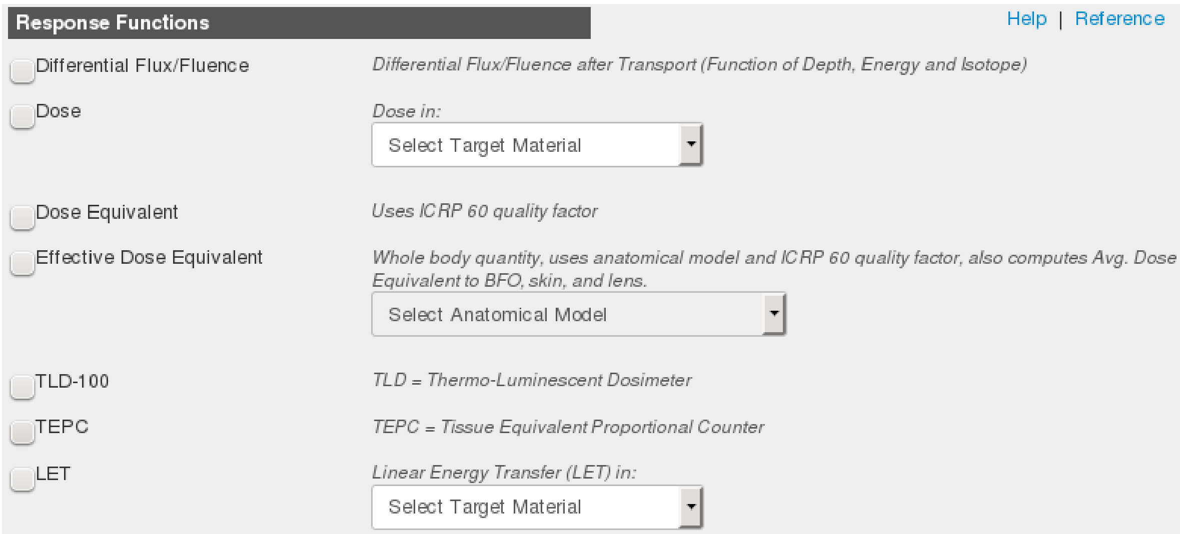
Spheres are defined the same as slabs in that any number of materials and any number of layers can be defined. This can be imagined as taking that layering and rotating around a target point to represent the sphere. The advantage of the sphere geometry is that whole-body effective dose equivalent can be computed. In this case, the flux/fluence is computed at the center of the sphere and then applied isotropic to the chosen body model. This represents an orientation averaged, or spinning astronaut, response. Transport is straight-ahead only in this case (no bidirectional neutrons).

Thickness distributions are handled two ways, either by interpolation-based responses or ray-by-ray response. The interpolation-based response is limited to 3 materials (2 + tissue if effective dose equivalent is required). In this case straight ahead transport is performed (*without* bi-directional neutrons) on a spatial grid for each material type in every combination but always in the same order of materials. This array of fluxes is then used to compute different response vs. depth tables, which are then used to compute the response along each ray by interpolation. Like materials are automatically collapsed together in the order the the response vs. depth computations. For example, if a thickness distribution has many layers of aluminum and poly and are mixed together, all of the aluminum layers are collapsed as the first layer, then all of the poly layers are collapsed as the second layer along each ray.

Ray-by-ray transport can support thickness distributions with as many as 5000 materials (or parts) in any order along each ray. In this case, straight ahead transport with bi-directional neutrons is performed along each ray and integrated with all the other rays to compute flux at a point. This flux is then used to compute the desired response. These jobs can take much longer to run, especially if effective dose equivalent is selected.

Response Selection

This section of the Project Form is for selecting the response functions to be evaluated and returned to the user:



Just about any combination of response functions can be chosen for most combinations of environment and geometry. However, there are some cases where the responses are limited. If that is the case, the user will not be able to select the response. The following table has a description of the responses.

Response	**Description**
Differential Flux/Fluence	This response is the output of the transport calculation. If the geometry is a thickness distribution, an array of flux/ fluence vs. depth (a spatial grid for each material), energy, and isotope is generated. In the case of a slab, the results are only for the spatial grid of the defined slab.
Dose	This response generates dose in tissue vs. depth (a spatial grid for each material) and dose at a point in the case of a thickness distribution.
Dose Equivalent	This response generates dose equivalent vs. depth (a spatial grid for each material) and dose equivalent at a point in the case of a thickness distribution. This calculation uses the ICRP (International Commission on Radiological Protection) 60 quality factor.
Effective Dose Equivalent	This response requires the choice of one of the available anatomical models - the Computerized Anatomical Female (CAF), Computerized Anatomical Man (CAM), Male Adult voXel model (MAX), or Female Adult voXel model (FAX) The body models are added to the user supplied thickness distributions. The thickness distribution must include either one or five raytraces. If one point is defined, all the body points are added to the one vehicle point. If 5 points are given, it is assumed that they are defined properly for a 5-zone calculation. In this case, the body points are summed to the closest vehicle point. This calculation uses the ICRP 60 quality factors and tissue weighting factors. This calculation also gives the effective dose equivalent averaged to each of the body organs, including averaged skin,

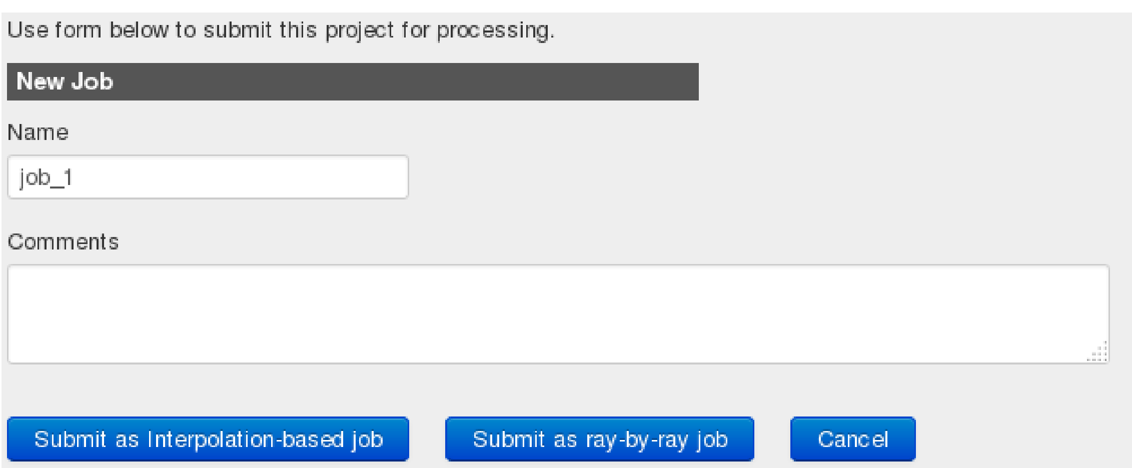
	Blood Forming Organs (BFO), and lens.
Thermo-Luminescent Dosimeter (TLD)	This response is calculated at all interpolation grid points and is called the TLD-100 Table or TLD-100 versus Depth Table. This table can be interpolated over a set of thickness files to obtain a TLD-100 value at a point inside a vehicle and/or human. This is a standard TLD-100 that is commonly flown on Shuttle and International Space Station (ISS). Used for validation.
Tissue Equivalent Proportional Counter (TEPC)	This response computes a value at a point defined in the thickness distribution. This is another instrument response like those carried on Shuttle and ISS. Used for validation.
Linear Energy Transfer (LET)	This response computes both differential and integral flux/ fluence vs. LET and depth (a spatial grid for each material) or at a point for the vehicle thickness distribution. A drop-down menu lets the user specify whether LET-related calculations use tissue or silicon as the target material.

Saving the Project

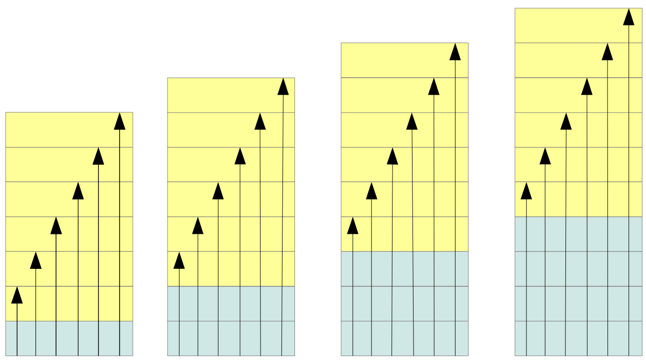
Two buttons are at the bottom of the project form, 'Create project,' or 'Cancel.' The button labeled Create project (or Update project if the user is editing an existing project) is used to save a project to the database. If any errors occur during the save, one or more error messages will be displayed at the top of the Content Area. The user is prompted to correct the entries in the Project Form that are in error. If the save is successful, the user will be shown the project summary and given the option to either return to the project list, submit the job, or edit the job. The Cancel button redirects the user to the Projects List.

Submitting a Job for Processing

A project can include multiple jobs so that if the user wants to change particular elements of the project, say select a different environment or response, the user can do so and create an additional job that can be submitted under that same project. Jobs can be submitted from the summary page or the projects page. After selecting the Submit button/link, the user will be shown a form for most jobs similar to this:



The job name will be filled in but can be updated by the user. The Comments box can be used to enter notes specific to this job. Then the user can send the job for processing by selecting one of the submit buttons. In this case the user can select to submit an Interpolation-based job or ray-by-ray job. This option is given for thickness distribution geometries that have 3 materials or less (two materials if the effective dose response is chosen, since one of the materials must be tissue to account for the body model). In the case of the interpolation-based job, like materials are grouped together and the transport is run on different thicknesses and combinations of materials to generate an interpolation table. The figure below shows a representation of two materials and the arrows represent 1-D, forward only, transport runs from the boundary through the various thicknesses.



These response vs. depth tables are generated for flux/fluence, dose, dose equivalent, and LET, if they are selected as responses, and they are returned in the results under the heading 'Computational Data Tables.' The target response is then computed by computing the response along each ray using these interpolation tables and then integrating over all the rays (sum then devide by the number of rays).

If a job is sent as ray-by-ray, then the full transport is run on each ray, which includes the forward-backward transport of neutrons. In this case, the opposite rays are included so that the backward neutrons are completely accounted for at the target. The responses are then computed from the flux/fluence at the target location. Ray-by-ray jobs can take much longer to run depending on how many rays are used. Also, if an effective dose response is required, the complexity increases further as the dose equivalent at each body point must be run as a separate jobs and then post-processed to compute the total effective dose.

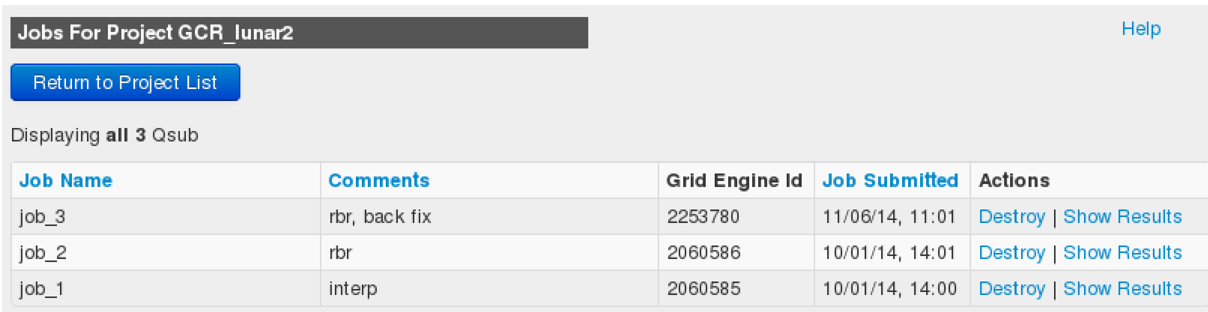
In some cases, ray-by-ray is the only option available for sending the job. This is the case if the thickness distribution has more than 3 materials or you specify a Mars surface environment.

Projects which require a user-supplied trajectory have two options for sending the job, either 'Averaged Trajectory' or 'Point-by-Point Trajectory.' In the former, the external environment (boundary condition) is computed at each trajectory point and integrated to obtain an average environment. The average environment is then run as a single job to provide total response quantities (and averaged per-day rates) for the entire trajectory. If instead the project is submitted as a 'Point-by-Point Trajectory' then the external environment is computed at *each*

trajectory point and run as a separate job. The results are then combined and returned as a function of time along the trajectory. These submissions can take much longer to run since there are as many jobs as there are time steps in the trajectory. The results files can also get quite large if desired responses include spectral data, such as boundary condition flux, flux after transport, or LET. It is best to start with a smaller number of points in the trajectory to get a feel for run time and the resulting data size. The status of this run cannot be checked; an email will be sent when the post-processing is complete.

Jobs List

Selection of a List Job link from the Projects List redirects the user to a list of all the jobs that have been submitted for a particular project.



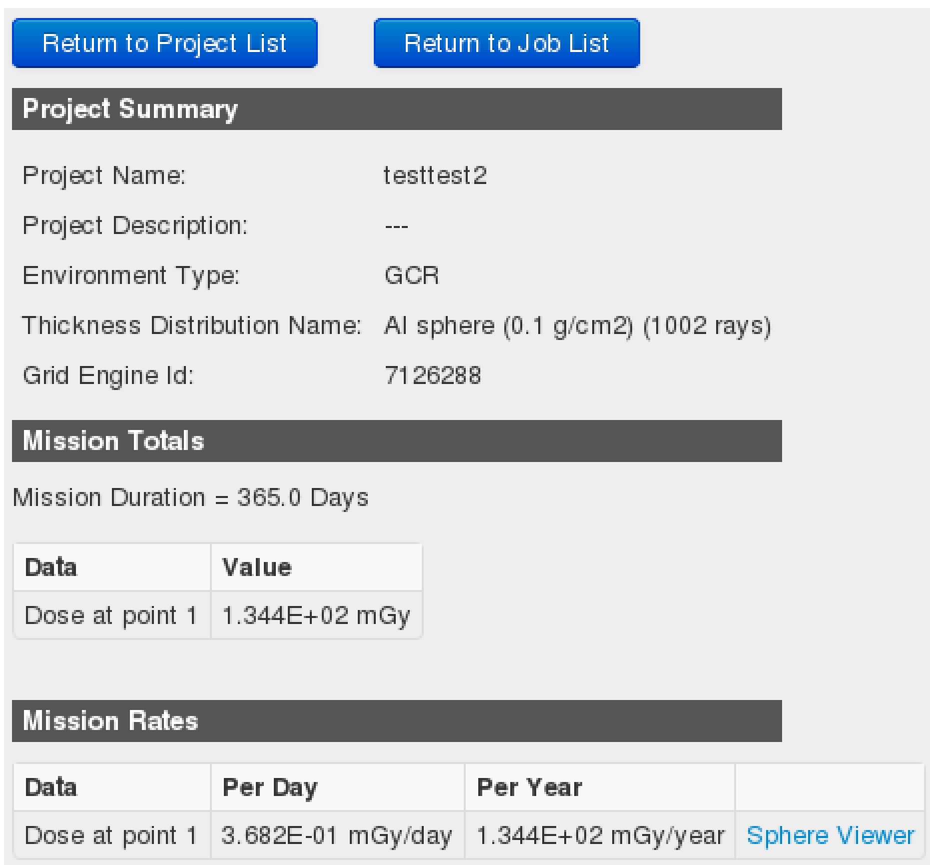
Above the Jobs List is a button for redirecting the user back to the Projects List and, in some cases, radio buttons for selecting which units of radiation to use when displaying results. The radio buttons are only provided when the job is associated with a design reference environment for the Europa mission. The user interface for the Jobs List is the same as is described in the General Usage section of this document. Listed below are attributes and links that are specific to the Jobs List:

Attribute or Link	**Description**
Grid Engine Id	This is the unique identifier that is assigned by the grid scheduler when the job is submitted. When the job completes, the email that is sent to the user uses this id to identify the job.
Job Submitted	This is the date and time that the job was submitted.
Destroy	Selection of this link deletes the job and its results. Deletion of a pending or active job does not remove it from the grid queue or stop it from running. You must contact the site administrators in order to stop a job that has already been submitted. This can be done by selecting the 'Send Comment' link at the top of the page.

Status	This link is for monitoring a job while it is running. The status of the job is displayed at the top of the content area in a box outlined in red. The status information includes the CPU time used by the batch job and the batch job state. When the job is complete, this link will turn to Show Results after the page has been refreshed. The user will also get an email from the grid scheduler after the job is finished. If the job fails, the email will have an Exit Status of 1 and the Job Status link will not change to Show Results. If this should happen, please send the gridengine id in an email to the site administrators using the Report Bug link at the top of the page.
Show Results	This link redirects the user to the Results Page

Results Page

The format of the Results Page will vary depending on the project's environment definition and response selection. The following example shows the Results Page that was generated for a GCR project:



Spectral Data Tables

Spectral Data	
Free-Space Boundary Flux (particles/(AMeV-day-cm2)) vs. Energy (AMeV) vs. Isotope	Plot/copy data | Download
Flux (particles/(AMeV-day-cm2)) vs. Energy (AMeV) vs. Isotope at Point 1	Plot/copy data | Download

Computational Data Tables

Data	
Dose (mGy/day) vs. Depth (g/cm2)	Plot/copy data | Download
Fraction of Dose (mGy/day) vs. Depth (g/cm2) by Particle Type	Plot/copy data | Download
Dose (mGy/day) vs. Depth (g/cm2) by Particle Type	Plot/copy data | Download
Flux (particles/(AMeV-day-cm2)) vs. Energy (AMeV) vs. Isotope vs. Depth (g/cm2)	Plot/copy data | Download

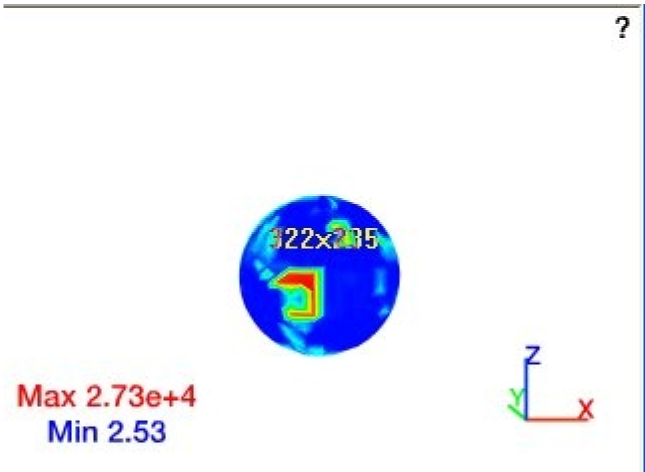
Download All Tables

The Results Page lists some of the results directly in tables. There are also links for plot data such as dose versus depth curves and flux/fluence data. The plot screen has a button for copying the plotted data to the user's clipboard so that it can then be pasted into various local applications on the client. The user also has the option to download the data to his or her desktop computer in the form of an ASCII compatible file.

[Note: The update to the user manual is current to this point, the rest of the document is still relevant, but the images may not match what is seen on the website.]

The Point Data Section of the Results Page

Point data is displayed for the entire mission duration. If effective dose is computed, the results are broken down to list the organ averaged dose equivalent to each organ and then the whole body effective dose equivalent as a separate quantity. Most point data can be better interpreted by viewing the directional contributions on a sphere. Selection of the Sphere Viewer link opens a pop-up window that contains the directional contributions shown as colors on a sphere. The axes displayed are related to the vehicle thickness distribution used in the calculation. The sphere can be rotated and the color fringes can be altered. Clicking on the '?' displays a help screen for the viewer.

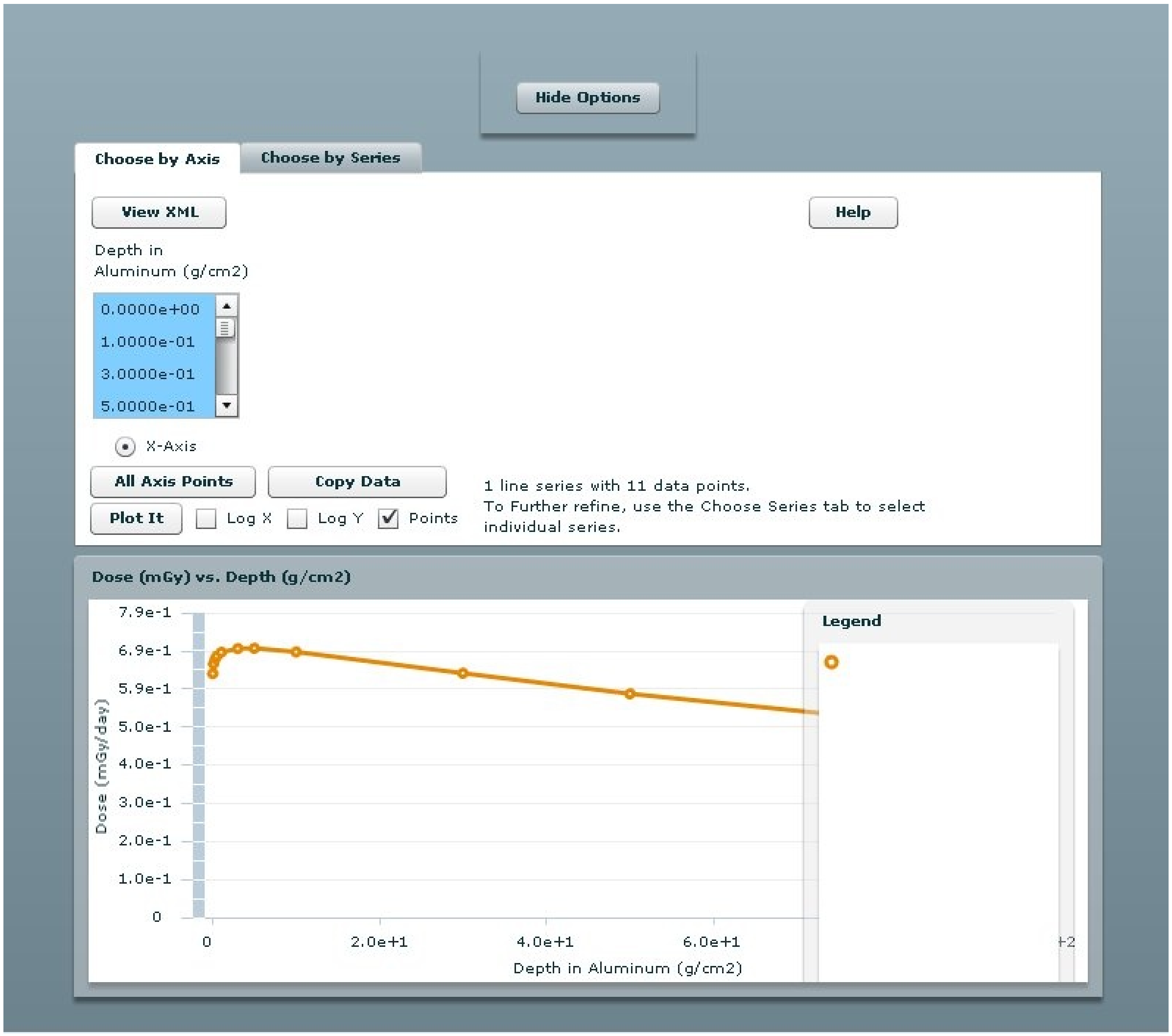


Point data for the entire mission duration is under the heading “Mission Totals”. If the project’s environment is EO, there are potentially extra tables where the data is broken down by component: one table of values for EO and GCR effects only and another table of values for Trapped Proton and Neutron Albedo Effects only.

If the project’s environment is a GCR or an EO with a GCR component then there will also be a “Mission Rates” heading. The table under “Mission Rates” contains the point data re-formulated as daily and per annum rates. Rates for EO projects are also broken down by component.

The Table Data Section of the Results Page

This section of the Results Page is for downloading or viewing table/array results. Selection of the Download link saves the data in an ASCII file which is downloaded to the client computer. Multidimensional array data in the file will be in column-major order. The Plot link invokes an Adobe Flash plug-in that has been customized for viewing OLTARIS data. Selection of the Help button in the Plot Window displays usage information. In addition to numerous plotting options, there is a Copy Data button that lets the user copy the data used for the current plot to the user’s system clipboard. This allows the user to paste it into Excel, Matlab, Sigmaplot, etc.



Project Summary

The Project Summary captures a project's attributes at the time the project was submitted to the SGE. If the project has been edited since then, the attributes in the project summary may differ from the project's current attributes. The intention of showing the summary is to document the inputs that yielded the results shown on the current Results Page.

Uploads → Thickness Distributions

The Thickness Distributions Module presents a list of the user's current thickness distributions and allows the user to upload new ones. Once a thickness distribution is uploaded, it can be selected for a project from the Projects Module. Thickness distributions are uploaded to the site in the form of an XML file. A document describing the format of the file and sample files can be downloaded from the Thickness Distributions page. The user can also download a phantom CAD object that represents a human geometry. This can be positioned and oriented in the user's CAD

software to help select the proper target points in their vehicle geometry for computation of effective dose responses.

Overview

Ray tracing process

Thickness distributions are computed using a process called ray tracing. Ray tracing uses a directionally distributed set of rays emanating from the same point to determine how much material is surrounding that point in each ray direction. The point source of the rays is commonly called a Target Point. The intersections of the rays and the various components of the vehicle CAD model are used to determine the along-ray thicknesses of the components, which are stored along with their associated material types.

Supported materials for interpolation-based transport

Interpolation-based transport generally supports three materials - aluminum, polyethylene, and tissue – in the vehicle raytrace. For example, one ray could intersect a human being, which would be a thickness of tissue, followed by some shielding material, which could be polyethylene, and then the vehicle structural components, which could be a thickness of aluminum. The user can substitute their own materials by re-defining the material type ids in the XML file. Rays typically intersect multiple objects, so there can be many separate material thicknesses along each ray. OLTARIS sorts and combines these thicknesses so that the outermost layer of shielding is composed of all the collected aluminum thicknesses along that ray, the next layer of shielding represents the total thickness of polyethylene along that ray and the innermost layer represents the total amount of tissue along that ray.

Supported ray distributions

Any angular distribution of rays may be used, as long as they are distributed evenly enough that each ray can be considered to represent an equal solid angle of shielding surrounding its target point. However, to compute an effective whole-body dose equivalent using OLTARIS, the user will need to use one of the many ray distributions that are available for download from the Thickness Distributions page. Those currently available include distributions with 42, 492, 512, 968, 1002, 4002, 9002, or 10,000 rays.

Phantom orientation

If the user needs to take into account a specific body phantom orientation with respect to their vehicle, OLTARIS provides a process that makes this possible. To calculate an effective dose, OLTARIS combines uploaded vehicle thickness distributions with pre-computed body phantom thickness distributions. The process used to combine these distributions provides the ability to analyze a specific body orientation relative to a vehicle shielding model and the ability to capture the local variation of radiation intensity inside the vehicle. This local variation could be due to variations in the amount of shielding surrounding different regions of the vehicle interior and might, for example, yield a situation in which the phantom's head was more lightly shielded than its feet.

In order to accurately represent the user's desired phantom orientation within a vehicle model, the user will need to download one of two specially developed CAD models from the OLTARIS web site. These CAD models are proxies for the male and female body phantoms that are

available for use in OLTARIS. The user will need to load this model into their CAD soft ware, as a new component in their shielding model. The models have been made available in an IGES (Initial Graphics Exchange Specification) file format to gain broad compatibility with the widest possible array of CAD software. Each body phantom proxy CAD model includes eight reference points.

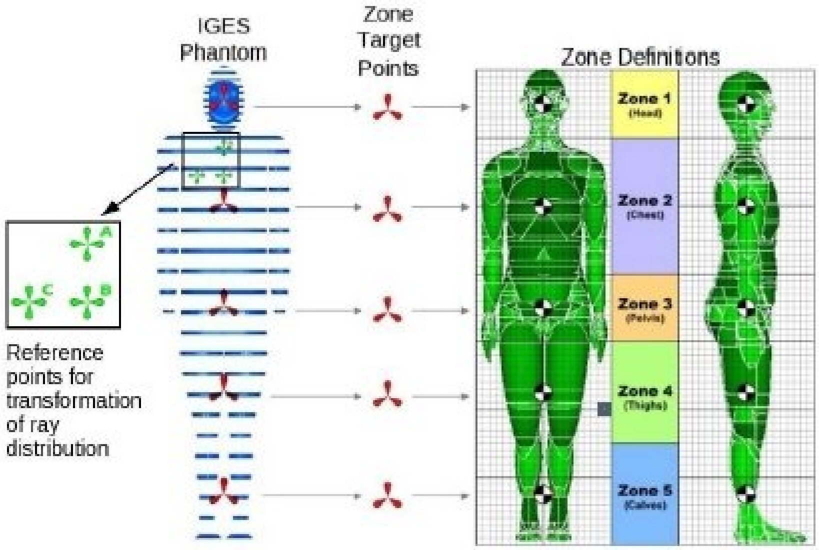


Figure 4 Body Phantom Zone Points

The three points used to establish the phantom orientation have been colored green and labeled “A”, “B”, and “C” (see Figure 4). Once oriented, the records the (x, y, z) coordinates of these three points, taking care to use the same reference coordinate system that will be used for ray tracing. The coordinates of these three points can be entered into a form on the OLTARIS website to generate a custom ray distribution, rotated to take the phantom orientation into account. The form used to create these ray distributions is accessed from the Thickness Distributions page. The user should use this ray distribution to ray trace vehicle thickness distributions that correspond to that phantom orientation.

The other five reference points included with each IGES phantom proxy are colored red and are used to capture the effects of shielding variation within the vehicle interior. These five points correspond to five body zones, as shown in Figure 4. To use this feature, the user will need to perform five separate vehicle ray traces and calculate five separate vehicle thickness distributions, each centered on one of the red zone target points. The effective whole-body dose equivalent calculation within OLTARIS uses tissue thickness distributions based upon hundreds of target points that are distributed throughout the body phantom in specific tissues. OLTARIS will add the vehicle thickness distribution closest to each of the zone’s tissue thickness distributions to get the total shielding around each body point. The user does not have to use the five target points, as one target point can be used in which all of the body points are added to the single vehicle thickness distribution. However, a single target point will be less accurate than the five target point case, as the local variations in the vehicle shielding may be significant.

Web Site Specifics

Thickness Distributions List

User defined and OLTARIS-supplied thickness distributions are listed.   These are the thickness distribution files that are supplied by OLTARIS:

File Name	Description
aluminum_poly_tissue_sphere	Three concentric spheres: 2 g/cm2 aluminum, 1 g/cm2 polyethylene, 3 g/cm2 tissue
aluminum_tissue_sphere	Two concentric spheres: 2 g/cm2 aluminum, 3 g/cm2 tissue
aluminum_sphere	2 g/cm2 aluminum sphere
STS_dloc2	All aluminum: Space Shuttle raytrace from Dosimetry Location 2
STS_dlocPB2	All aluminum: Space Shuttle raytrace from Dosimetry Location 8 in payload bay

The user interface for the Thickness Distributions List is the same as described in the General Usage section of this document.

A note about the view link: Selection of the view link redirects the browser to display a thickness distribution in raw XML. These xml files tend to be large and can be slow to load. Also, the browser's back button must be used to return to the Thickness Distributions List.

Links for Creating Thickness Distributions

Link	Description
Human Phantom Overview	This link downloads a pdf or PowerPoint file that contains a description of the overall process of adding a human phantom into an uploaded space vehicle shielding distribution, to enable the calculation of whole body effective dose.
Download Thickness Metafile Description	This link downloads a pdf file that contains a description of the XML format required for uploading thickness distributions to OLTARIS.
Download Example Thickness Metafiles	This link downloads a zip file containing example thickness distributions in XML format. These files can be used as a model for the user's own thickness files.
Download Phantom Geometries	This link downloads an IGES representation of the phantom that can be oriented in the user's vehicle. After the phantom has been oriented, the user will have to return to the Thickness Distributions Module and download a rotated ray distribution.
Download Un-rotated Ray Distribution	This link redirects to a form for downloading one of the eight available ray distributions. The images link on the form displays pictures of the available downloads. The ray distribution files are selected from a drop-down menu.

Download Rotated Ray Distribution	This link redirects to a form that lets the user download a rotated ray-distribution that is oriented so that vehicle can be ray-traced in the same coordinate system as the phantom. The images link on the form displays pictures of the available downloads. The ray distribution files are selected from a drop-down menu. The form also contains fields for entering the x-, y-, z-coordinates in the vehicle coordinate system. These points uniquely determine the position and orientation of the phantom within a vehicle model.
Upload Thickness Metafile	This link uploads an XML thickness distribution from the client to the OLTARIS website. During the upload, OLTARIS will check to validate that the uploaded file is a properly composed thickness file. This action can is also linked to from the button above the Thickness Distribution List.

User Defined Materials and Thickness Distributions

Although the number of materials within a thickness distribution can be no more than three, it is possible to create a thickness distribution that specifies three materials other than the default aluminum, polyethylene, and tissue:

1. Use the “Download Thickness Metafile Description” button to download the “Radiation Shield Thickness Metafile Format” document.

2. Review document sections describing the *Material Table Element* and the *Material Element*. The material table defines how material identification numbers map to material names within the thickness distribution. The Material Table Element contains one or more Material Elements. Each Material Element has two main attributes:

    - *material_id* which is unique to this material in the material table. Each thickness in a thickness distribution will use this id number to associate that thickness with the proper material.

    - *type_id* that identifies the type of material that will be used for transport calculations. Possible values are 1, 2 or 3.

3. Hand edit the thickness distribution, adding up to three elements to the Material Table:

    <material_type_define id="1" user_material_name=”User Material 1”>

    <material_type_define id="2" user_material_name=" User Material 2”>

    <material_type_define id="3" user_material_name=" User Material 3" />

    These statements cause the user-defined material named ”User Material 1" to be associated with all Material Elements with type-id equal to 1, "User Material 2" to be associated with all Material Elements with type-id equal to 2, and "User Material 3" to be associated with all Material Elements with type-id equal to 3.

4. Be sure that you have created the user-defined materials that are referenced. The following error appears if the user-defined materials named in step 3 are not already created be-

fore uploading the thickness distriution: “Material that is in the material table not found in the database.”

Uploads → Trajectories

The Trajectories Module can be used to upload a trajectory file corresponding to an orbit around Earth. Upon selection of Uploads->Trajectories from the OLTARIS main menu, the user is presented a list of files that have already been uploaded and a button for uploading new trajectory files.

File Formats for Uploading Trajectories

At the bottom of the main page of the Trajectory module is a link for displaying a document that describes the file formats that can be used to upload a trajectory. Each format is described in detail and example files are provided for each format.

Form for Uploading a Trajectory

Select the “Upload a Trajectory ...” button at the top of the main page of the Trajectories Module to bring up the form for uploading a trajectory file. Follow these steps to upload a trajectory:

1. Enter comments relevant to the trajectory in the textbox at the top of the form. Entry of comments is optional.
2. Click on “Browse” and navigate to the saved file on your computer.
3. Click “Open”.
4. Click “Upload Trajectory File”.
5. If the upload is successful, the user is redirected back to the main page of the Trajectories Module. An entry for the newly uploaded trajectory appears at the top of the list of

trajectories. If the upload is unsuccessful, then an error message is displayed at the top of the upload form.

The Trajectory Viewer

The plot link that is associated with each entry in the Trajectory List brings up a tool for visualizing the trajectory against 2D or 3D Google Maps of Earth. The trajectory can also be viewed as three 2D Time Series plots: Latitude vs Time, Longitude vs Time and Altitude vs Time.

How to Use a Trajectory in a Project

Once a trajectory is uploaded, it can be applied to a project by following these steps:

1. Click on the “Add another project ...” button at the top of the Projects main page to redirect the display to the form for creating a new project; and then click on the “Earth Orbit/ Trajectories” button to redirect the display to the form for creating earth orbit environments.

2. Click on the “User Trajectory” button on the Earth Orbit/ Trajectories form. This causes a pull-down menu of uploaded trajectories to be added to the form. Choose a trajectory from the menu. The “Start Date” selector will be updated if the chosen trajectory file specifies a mission start-date. The start date can be changed in the form if desired, that way the same trajectory can be used for different periods in the solar cycle without having to upload another trajectory.

3. Finish filling out the Earth Orbit/ Trajectories form and then click on save button. Note that Neutron Albedo isn't supported and is grayed out..

4. Save the project after you are done filling out the new Project form.

5. Click on the “+Submit Job” link that is associated with the project that was created in the previous step.

6. Submit job by clicking on either the “Submit as averaged trajectory” button or the “Submit as point-by-point trajectory” button.

7. If a job is submitted as an average trajectory, the status of that job can be checked as with any other type of job. If the job is submitted as a point-by-point trajectory, there is no mechanism for checking the status. The user will get an email when the post-processing is complete.

Slabs

Although OLTARIS provides a few predefined materials, the user will in most cases first define the materials he or she wants to use in the Materials Module. Once a material is defined, the user then goes to the Slabs Module and defines a layup of any thickness of material, in any order the

user chooses. This capability is useful for comparing new material or structural concepts. Once a slab is created, it can be selected for a project from the Projects Module.

Slabs List

The user interface for the Slabs List is as described in the General Usage section of this document. There are 3 action links:

Link	Description
Show	This link redirects to a page that displays the slab's composition; i.e., the number of layers, material type of each layer, thickness of each layer and total slab thickness. Slab layers are presented in a sortable list. Layers can be dragged up and down the list to change their order both on the page and in the slab. To drag, the user left clicks on the slab layer and drags the layer to its new destination in the slab.
Edit	This link redirects to the form for editing a slab.
Destroy	This link deletes a slab definition. Note, a slab cannot be deleted if it is referenced by one or more projects. In this case, a warning will be displayed at the top of the Content Area. The warning will identify which projects reference the slab.

The button above the Slab List redirects the browser to the form for creating a new slab. Identical forms are used for creating and editing slabs.

Form for Creating and Editing Slabs

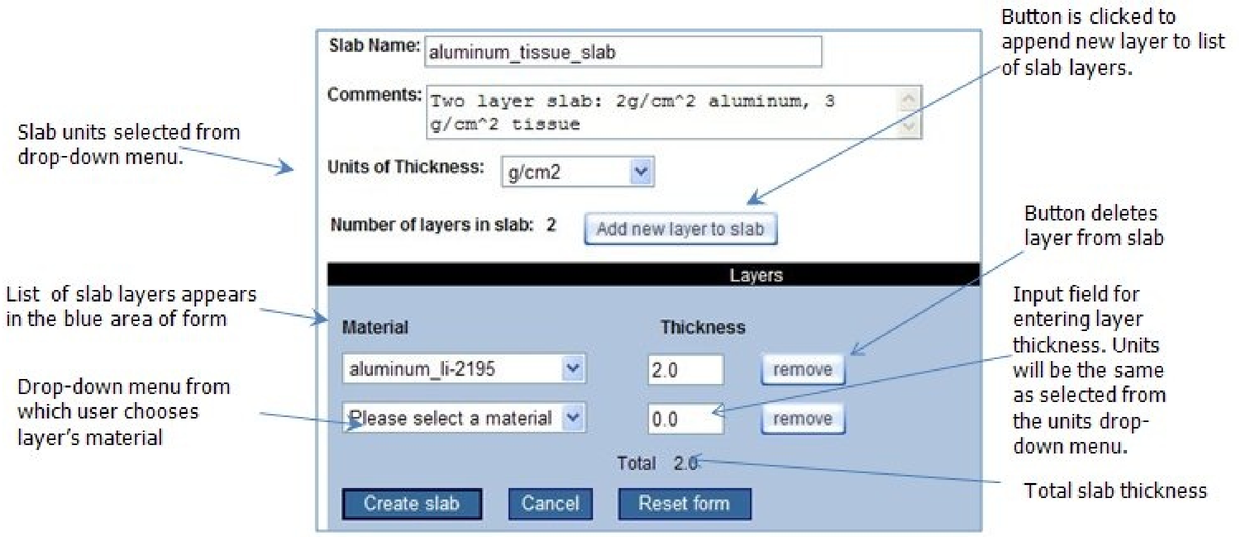


Figure 5 Form for creating and editing slabs.

The Slabs Form is used to define the necessary attributes of a slab including the slab name, number of layers, material type of each layer, thickness of each layer, and units of thickness. Comments are optional. The total thickness of the slab is computed as the thickness of each layer is entered.

A Note on Units: Slab units are selected in the drop down menu. Ultimately, all thickness units are converted to g/cm2 for the transport procedure and response function calculations. Plots and output data files with spatial information are also given in g/cm2.

Materials

The user defines a material by entering the material's mass percentage, its molecular mass percentage, or its chemical formula. After the material is defined, the user can submit the material definition to the computational grid so that material cross sections can be computed for later use. The user receives email notification when the processing of the material is complete and the material cross sections are available.

Once a material is defined, the user can go to the Slab Module and assign that material to slab layers. The name of the material will appear in the drop-down menu of materials associated with each layer (see Figure 5) in the Slab Form. Slabs referencing that material can also be selected for a project. It is not until the user submits the project to the grid scheduler (SGE) that OLTARIS checks that the cross-sections have been computed for the material. If no cross-sections are available for one or more materials that are referenced by the project, a warning is displayed that identifies the materials for which no cross-sections have been generated.

User-defined materials can also be used in thickness distributions by using the material name in the material_type_define element of the XML file.

At this time, only naturally occurring isotopes, except for Neon, can be used to define a material. Neon and Boron-10 cannot be used; Boron-11 is assumed to be the naturally occurring isotope for Boron.

OLTARIS only accounts for nuclear and atomic interactions in the transport of charged and neutral particles through bulk matter. Therefore, molecular interactions, bond structures, etc. are neglected and the following molecular formulas are considered equivalent: C8Co2(O8) = C8CoO16.

Materials List

The user interface for the Material List is as described in the General Usage section of this document. Figure 6 shows a screen capture of part of one user's list:

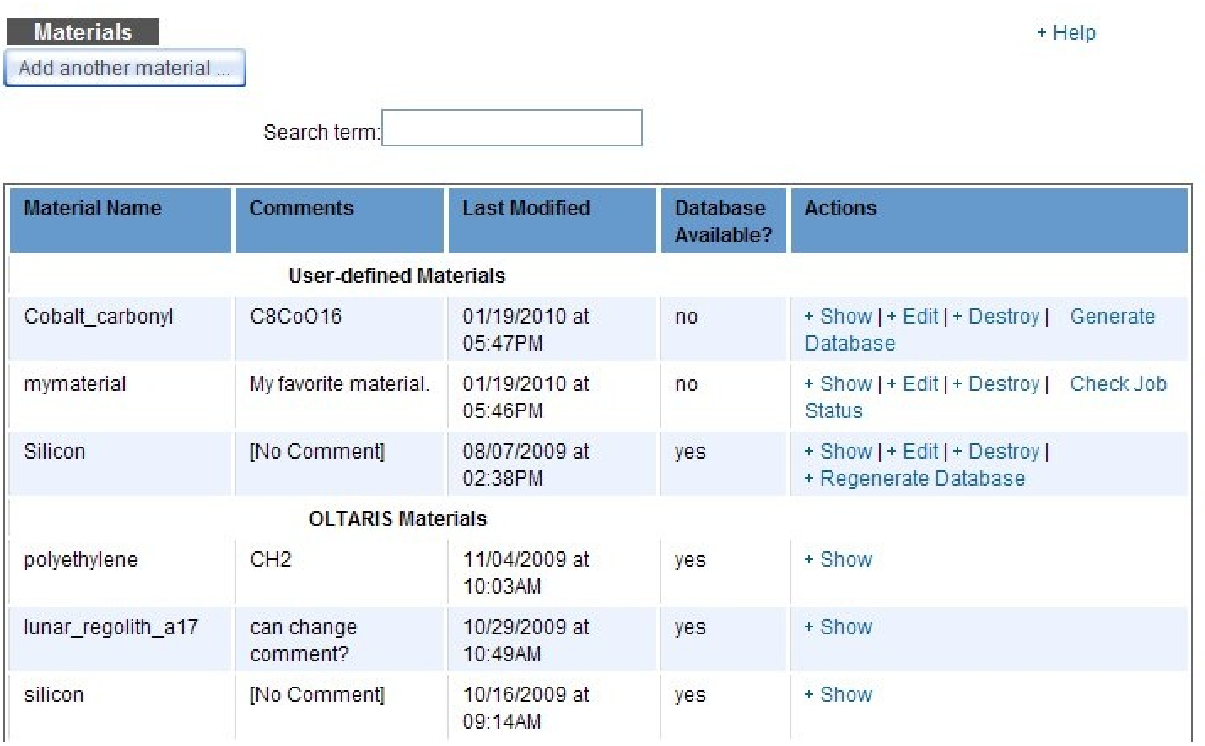


Figure 6 Materials List

The fourth column of the Material List is titled "Database Available?" A yes in this column indicates that the cross-sections for this material have been generated and no indicates that they have not been generated.

There are 5 links that appear in the column that is titled "Actions":

Link	Description
Show	This link redirects to a page that displays a summary of the material composition. The summary displays the material definition, density and density units.
Edit	This link redirects to a form that can be used to edit the material's composition.
Destroy	This link deletes a material. A material cannot be deleted if it is currently used in a slab definition. The slab would have to be changed or deleted before the material can be deleted.
Generate Database	This link submits a material to the grid scheduler (SGE) so that cross sections can be generated. A message is displayed at the top of the Content Area informing the user that the job was sent and the link will change to Check Job Status. An email is sent from the grid manager to the user when the job is finishes.

Regenerate Database	This link re-submits a material to the computational grid so that the material cross sections can be re-computed. The user needs to re-generate a material's cross section after a material's attributes, other than name and comments, are changed.
Check Job Status	This link shows the status of the grid job that is computing the cross-section database. If the message indicates No Jobs Pending, then the job is no longer running and the "Database Available?" column should indicate yes. If it doesn't, then the database generation failed and the user should submit a bug report. Once the job has completed successfully, this link will change to Regenerate Database.

Form for Creating Materials

The button labeled "Add another material …" links to the form for creating materials. There are three ways to define a material – Elemental Mass Percentage, Molecular Mass Percentage, and Chemical Formula. The user must select one to start as shown in Figure 7. Density units can be selected in the drop down menu. Ultimately, all density units are converted to g/cm3.

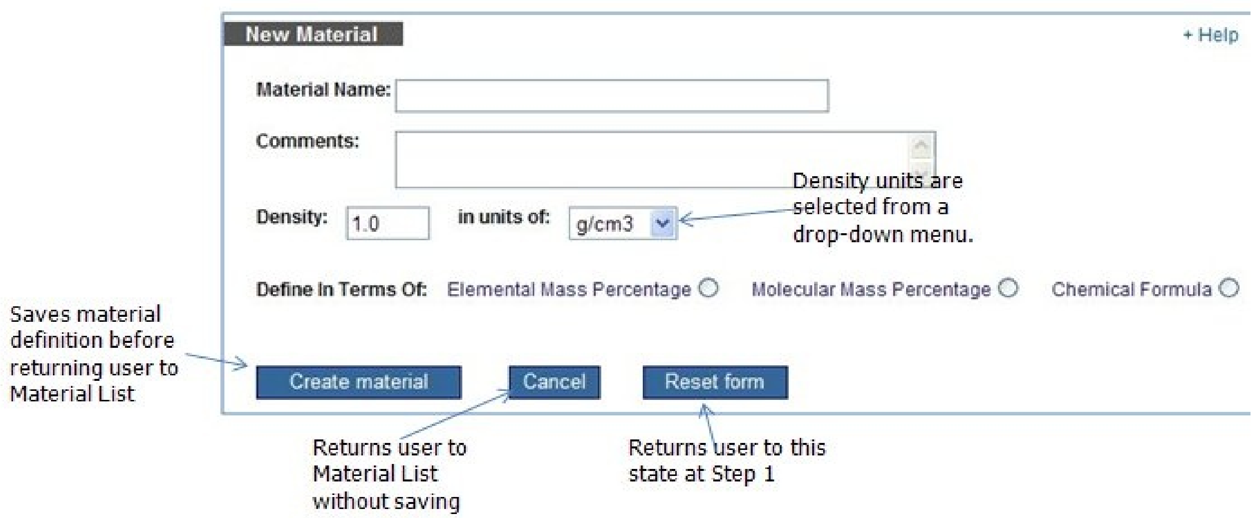


Figure 7 Step 1 is to choose the Definition Style

The screen will change depending on the Definition Style that is selected. Figure 8 shows an example screen for Elemental Mass Percentage. The user must know the mass, charge and mass percentage of each element in the material. Only naturally occurring elements can be used at this time. The sum of all percentages must add up to 100.

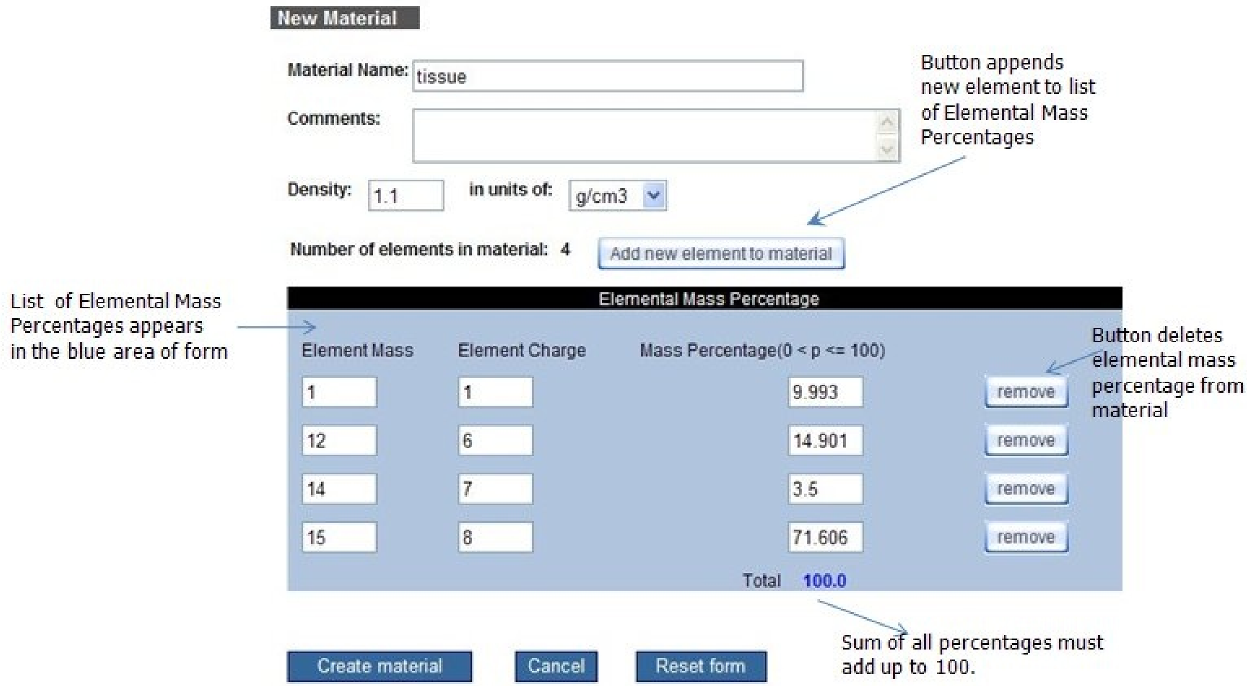


Figure 8 Example of screen for Elemental Mass Percentage

Figure 9 shows an example screen for the Molecular Mass Percentage definition style. The user enters the chemical formula and mass percentage of each molecule in the material. Formulas are input by entering the chemical symbols of each constituent element followed by the number of atoms. Formulas are input using plain text. The show formula button lets the user view the formula with atomic number indicated using a subscript. Although not shown in Figure 9, there is a blue box at the bottom of the screen that has some example chemical formulae to help the user figure out the input format.

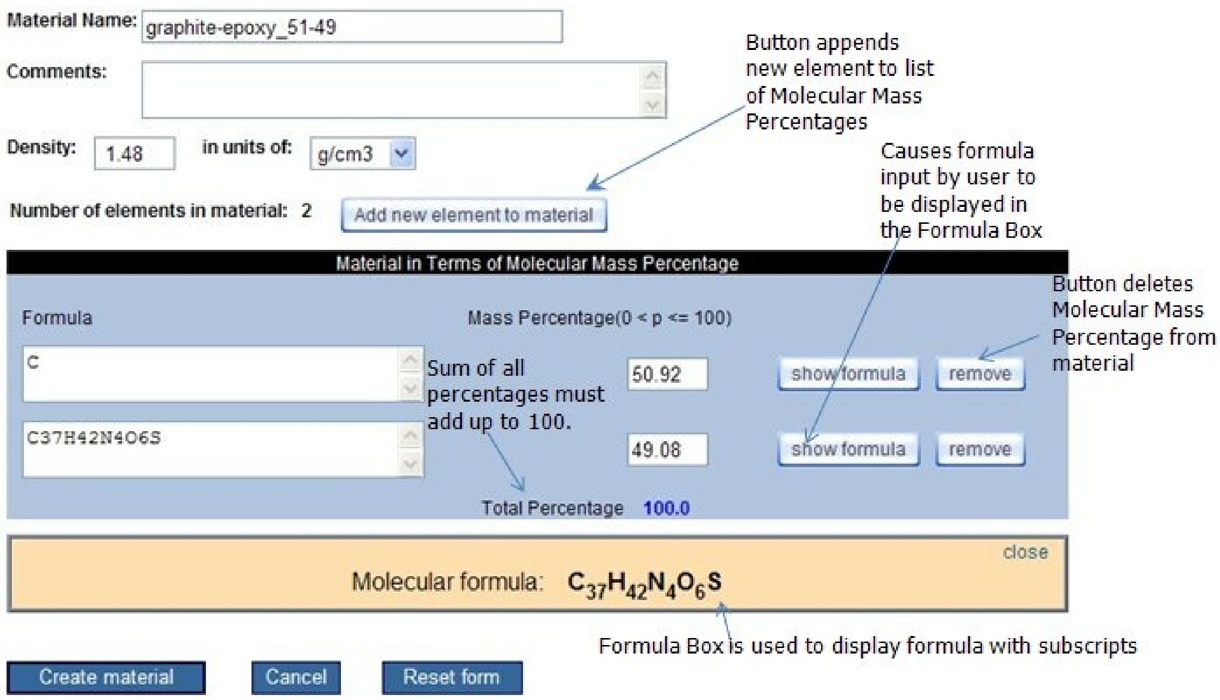
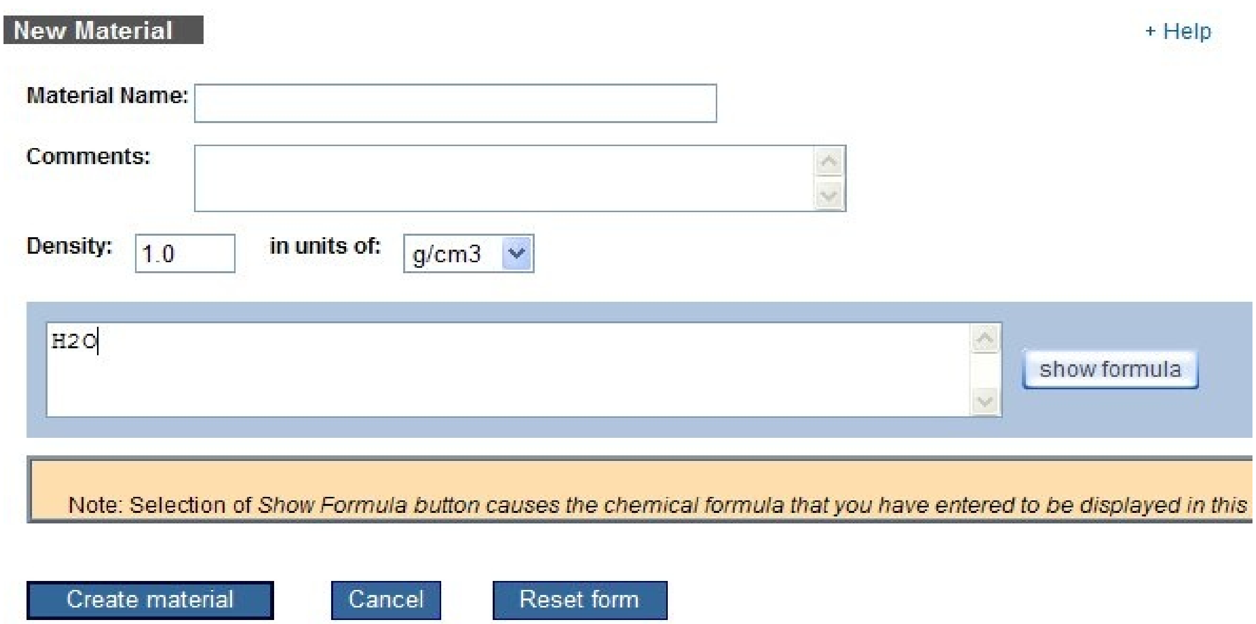


Figure 9 Example screen for Molecular Mass Percentage

Figure 10 shows an example screen for the Chemical Formula definition style. This form operates similarly to the one for Molecular Mass Percentages except that only one formula is entered.



Form for Editing Materials

The form for editing a material definition is same one as is used for creation. The difference is that the user skips the first step because the definition style is fixed after creation. Changing any part of the material definition (except name and comments) invalidates any existing cross-sections for the material. They will need to be re-generated.

Documentation

This module contains links for downloading user documentation and various reports.

Log Out

Logging out from OLTARIS is done explicitly by selection of the Log Out item from the Main Menu. It can also be done implicitly, such as by powering the machine off or closing the web browser window. The OLTARIS login system uses a session-only cookie to authenticate the user. When the user logs out, this session-only cookie is deleted from the user's computer. As a security precaution, one should not rely on implicit means of logging out of OLTARIS, especially not on a public computer; instead one should explicitly log out and wait for the confirmation that this request has taken place.